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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
C07D 231/10, 231/44, 231/38, C07C 317/48, 317/44, 255/65

A1

(11) International Publication Number: WO 98/40358

(43) International Publication Date: 17 September 1998 (17.09.98)

(21) International Application Number: PCT/EP98/01226

(22) International Filing Date: 5 March 1998 (05.03.98)

(30) Priority Data:
815,848 12 March 1997 (12.03.97) US

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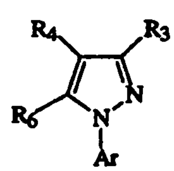
(81) Designated States: AL, AU, BA, BB, BG, BR, CA, CN, CU, CZ, EE, GE, GW, HU, ID, IL, IS, JP, KP, KR, LK, LR, LT, LV, MG, MK, MN, MX, NO, NZ, PL, RO, SG, SI, SK, SL, TR, TT, UA, US, UZ, VN, YU, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PROCESS FOR PREPARING PYRAZOLE DERIVATIVES



(IV)

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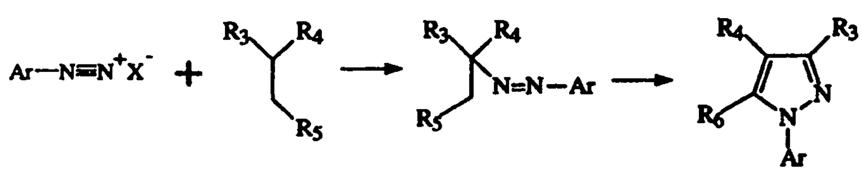


(I) (II) (III) (IV)

(57) Abstract

The invention relates to a process for preparing compounds having formula (IV), wherein R_3, R_4, R_6 and Ar are as defined in the description, by reaction of a compound of formula (I) with a compound of formula (II) according to reaction scheme. The compounds of formula (IV) are useful as pesticides.

PROCESS FOR PREPARING PYRAZOLE DERIVATIVES

The instant invention is directed to a new process for manufacturing pesticidally active materials as well as the intermediates thereof. More particularly, the instant invention is directed to a process for manufacturing 1-aryl substituted pyrazoles.

Many manufacturing processes have been described in the literature for preparing such derivatives, for example in International Patent Publication Nos. WO87/03781, WO93/06089 and WO94/21606; in European Patent Publication Nos. 0295117, 0403300, 0385809 and 0679650; US Patent Nos. 5232940 and 5236938; and German Published Patent Application No. 19511269.

The Japp-Klingemann reaction, reviewed in *Org. React.*, Vol. 10, pages 143-178 (1959), known in the literature since 1887, is a process by which phenyl azo compounds are formed from the reaction of diazonium salts with active methylene compounds. Typically the phenyl azo compound is not isolated, but is reacted *in situ* with base resulting in loss of a leaving group and formation of the corresponding hydrazone. When the phenyl azo intermediate is properly substituted, a spontaneous cyclization reaction occurs giving a 3,5-disubstituted-4-protio-pyrazole, that is, a 3,5-disubstituted-4-unsubstituted pyrazole. If a 3,4,5-trisubstituted pyrazole is desired, further manipulation is required in subsequent steps.

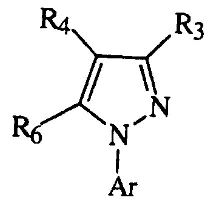
An object of the instant invention is to provide a new manufacturing process for preparing arylpyrazole derivatives.

Another object of the instant invention is to provide a simple manufacturing process, if possible, more simple than the existing process.

These objects are met in whole or in part by the instant invention.

This invention provides a new and more efficient process for the direct preparation of 3,4,5-trisubstituted-1-arylpyrazoles. Surprisingly, it has been found that the pyrazole ring cyclization of certain aryl azo intermediates proceeds such that the leaving group (normally lost in these type of reactions) is reincorporated into the pyrazole at C-4 thus giving immediate access to 3,4,5-trisubstituted-1-arylpyrazoles. This offers advantages in reducing the number of reaction steps required to produce the desired pesticidally active 3,4,5-trisubstituted-1-arylpyrazole derivatives, which in turn means less waste chemical may be generated when manufacturing such compounds; and less energy may be needed. This also helps to reduce the manufacturing cost of the pesticidally active 1-aryl pyrazole derivatives.

The present invention provides a process for preparing 1-arylpyrazoles wherein:



(IV)

wherein:

Ar is optionally substituted phenyl or optionally substituted pyridyl;

R_3 is $-C(O)R_8$, -CN, $-CO_2H$, $-C(O)NHR_8$, -CHO, $-C(O)CO_2R_8$, $-S(O)_mR_8$, $-C(O)CH_2$Het, Het, $-C(O)CH_2R_9$, $-C(O)(C_1\text{-}C_6$ alkyl), $-C(O)(C_1\text{-}C_6$ haloalkyl), -C(O)styryl, halogen, $-C(O)OR_8$, $-P(O)(OR_8)_2$, $-P(S)(OR_8)_2$, $-NO_2$, R_9 or $-S(O)_m$styryl;

R_4 is as defined for R_3 excluding -CN and halogen;

m is 0, 1 or 2;

R_6 is $-NH_2$, -OH or $-CH_3$;

R_8 is $C_1\text{-}C_6$ alkyl, $C_1\text{-}C_6$ haloalkyl, R_9 or Het;

Het is a 5- or 6-membered heterocyclic ring, said ring having from one to three ring heteroatoms which are the same or different selected from the group consisting of nitrogen, sulfur and oxygen, each carbon atom of said ring being unsubstituted or being substituted by halogen, $C_1\text{-}C_6$ alkyl, $C_1\text{-}C_6$ haloalkyl, $C_1\text{-}C_6$ alkoxy, $C_1\text{-}C_6$ haloalkoxy, cyano, nitro, amino, N-($C_1\text{-}C_6$ alkyl)amino, N,N-di($C_1\text{-}C_6$ alkyl)amino, OH, $-S(O)_m(C_1\text{-}C_6$ alkyl) or $-S(O)_m(C_1\text{-}C_6$ haloalkyl); and

R_9 is phenyl optionally substituted by one or more members selected from the group consisting of halogen, $C_1\text{-}C_6$ alkyl, $C_1\text{-}C_6$ haloalkyl, $C_1\text{-}C_6$ alkoxy, $C_1\text{-}C_6$ haloalkoxy, cyano, nitro, amino, N-($C_1\text{-}C_6$ alkyl)amino, N,N-di($C_1\text{-}C_6$ alkyl)amino, -OH, $-S(O)_m(C_1\text{-}C_6$ alkyl) and $-S(O)_m(C_1\text{-}C_6$ haloalkyl);

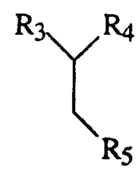
said process comprising:

(a) reacting a compound having the formula:

$$Ar{-}N{\equiv}N^{+}X^{-}$$

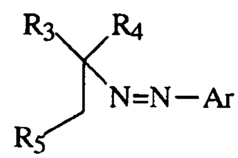
(I)

wherein Ar is as defined above and X is a compatible anion, with a compound having the formula:



(II)

wherein R_3 and R_4 are as defined above and R_5 is -CN, -C(O)OR$_8$ or -C(O)(C_1-C_6 alkyl), to afford the corresponding compound having the formula:



(III)

wherein R_3, R_4, R_5 and Ar are as defined above; and

(b) subjecting the compound of formula (III) thus obtained to rearrangement to afford the corresponding compound of formula (IV).

In the specification the following terms have the general meanings given below:

"alkyl" is branched or straight chain alkyl having from 1 to 6 carbon atoms;

"haloalkyl" is branched or straight chain alkyl having from 1 to 6 carbon atoms, bearing one or more halogen which are the same or different;

"alkoxy" is branched or straight chain alkoxy having from 1 to 6 carbon atoms;

"haloalkoxy" is branched or straight chain alkoxy having from 1 to 6 carbon atoms, bearing one or more halogen which are the same or different;

"halogen" means fluorine, chlorine, bromine or iodine.

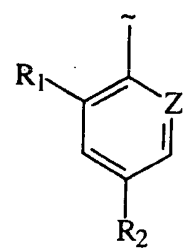
In the definition above it will be understood that R_4 cannot represent -CN or halogen because in formula (III) above, -CN or halogen cannot migrate to the adjacent carbon atom in the rearrangement step to give the compound of formula (IV) above.

X can be any anion compatible with the reaction conditions prevailing. Examples of suitable groups include (HSO_4), halogen, (BF_4), ($ZnCl_3$) and ($CoCl_3$). Preferably X is halogen or (HSO_4).

When Ar is phenyl, it has from 0 to 5 substituents. When Ar is pyridyl, it has from 0 to 4 substituents. Preferably, Ar has from 1 to 3 substituents. In any event, the

optional Ar substituents are preferably selected from the group consisting of halogen, CN, NO_2, haloalkyl, haloalkoxy, $S(O)_mCF_3$, SF_5 and R_{10} wherein m is as defined above and R_{10} is as defined below.

Preferably Ar is a group having the formula



wherein:

Z represents a trivalent nitrogen atom or a C-R_7 radical, the other three valences of the carbon atom forming part of the aromatic ring;

R_1 and R_7 represent, independently of each other, a hydrogen or halogen atom, or CN or NO_2;

R_2 represents halogen, haloalkyl, haloalkoxy, $S(O)_mCF_3$, SF_5 or R_{10};

and R_{10} is phenyl optionally having from one to five substituents selected from the group consisting of halogen; alkyl; haloalkyl; cyanoalkyl; cyano; nitro; amino; hydrazino; alkoxy; haloalkoxy; haloalkylcarbonyl; formyl; alkylcarbonyl; thiocarbamoyl; carbamoyl; alkoxycarbonyl; SF_5; and $R_8S(O)_m$ (preferably the 4-position substituent being halogen, haloalkyl or haloalkoxy); two adjacent phenyl substituents being optionally joined together form a 1,3-butadienylene (-CH=CH-CH=CH-), methylenedioxy (-O-CH_2-O-) or halomethylenedioxy (*e.g.*, -O-CF_2-O-) group so as to form a cyclic ring vicinal to the phenyl ring.

The following are also preferred embodiments of the invention, especially when Ar is one of the preferred groups depicted above:

R_3 is -CN or -COR_8; and/or

R_4 is -$S(O)_mR_9$, -$S(O)_m$alkyl or -$S(O)_m$haloalkyl; and/or

R_5 is -CN; and/or

R_6 is -NH_2.

The following value of the various substituents provide representative compounds of formulae (I) to (IV) above. In the Table that follows "Ph" means phenyl; "Pyr" means pyridyl; "Et" means ethyl.

Ar	X	R_3	R_4	R_5	R_6
2,6-Cl_2-4-CF_3 Ph	HSO_4	$COCH_3$	SO_2(4-Cl Ph)	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	SO_2(4-Cl Ph)	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	CO_2Et	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	$SOCF_3$	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	$SOCH_3$	CN	NH_2
2,6-Cl_2-4-OCF_3 Ph	Cl	Cl	$SOCF_3$	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	SOEt	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	$P(O)(OEt)_2$	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	Cl	CN	SO_2CF_3	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	SO(4-Cl Ph)	$COCH_3$	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	$COCF_3$	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	NO_2	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	NO_2	$COCH_3$	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	SO_2(2-thienyl)	$COCH_3$	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	$COCH_3$	SO_2(2-thienyl)	CN	NH_2
2,6-Cl_2-4-(4-Cl Ph) Ph	HSO_4	CN	$SOCF_3$	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	Br	$COCH_3$	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	Br	COPh	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	CO(2-furyl)	CN	NH_2
2,6-Cl_2-4-CF_3 Ph	HSO_4	CN	$SOCF_3$	CN	NH_2
2,6-Cl_2-4-SF_5 Ph	HSO_4	$COCH_3$	SO_2(4-Cl Ph)	CN	NH_2
2,6-Cl_2-4-SF_5 Ph	HSO_4	CN	SO_2(4-Cl Ph)	CN	NH_2
2,6-Cl_2-4-SF_5 Ph	HSO_4	CN	CO_2Et	CN	NH_2
2,6-Cl_2-4-SF_5 Ph	HSO_4	CN	$SOCF_3$	CN	NH_2
2,6-Cl_2-4-SF_5 Ph	HSO_4	CN	$SOCH_3$	CN	NH_2
2,6-Cl_2-4-SF_5 Ph	Cl	Cl	$SOCF_3$	CN	NH_2
2,6-Cl_2-4-SF_5 Ph	HSO_4	CN	SOEt	CN	NH_2
2,6-Cl_2-4-SF_5 Ph	HSO_4	CN	$P(O)(OEt)_2$	CN	NH_2
2,6-Cl_2-4-(4CF_3 Ph) Ph	HSO_4	CN	$SOCF_3$	CN	NH_2
2,6-Cl_2-4-(4-OCF_3 Ph) Ph	HSO_4	CN	$SOCF_3$	CN	NH_2

Ar	X	R_3	R_4	R_5	R_6
2,6-Cl_2-4-O Ph	HSO_4	CN	$SOCF_3$	CN	NH_2
2,6-Cl_2-4-(4-SCF_3 Ph) Ph	HSO_4	CN	$SOCF_3$	CN	NH_2

The process of the invention is generally conducted in two steps, although it may be carried out as a continuous process including the *in-situ* rearrangement of the compound of formula (III) to give a compound of formula (IV). This *in-situ* process may be preferred when the process forms part of a manufacturing process, as it may avoid the need for isolation of the intermediate of formula (II).

In the first step the diazonium salt (I) is reacted with a compound (II) in a solvent, with protic solvents such as methanol, ethanol and acetic acid being preferred. The reaction is performed, optionally in the presence of a base, at a temperature between about 0° and about 120°C, preferably between about 0 and about 25°C, to give the azo product (III). When base is used in this step, it can be organic such as pyridine or triethylamine, or inorganic such as potassium carbonate or sodium hydroxide. When used, the amount of base is generally from about 1 to about 25 equivalents [based on the mole equivalents of the compound of formula (I)], with about 1 to 5 equivalents being preferred.

In the second step of the reaction sequence, the azo compound (III) is dissolved in a suitable solvent and optionally subjected to up to about 20 equivalents of a base, preferably up to about 5 equivalents, to give the rearranged pyrazole of formula (IV). The reaction temperature for this step is from about 0 to about 120°C, preferably from about 0 to about 25°C. The solvent can be protic such as methanol, ethanol or acetic acid, or preferably the solvent can be aprotic, such as dichloromethane, tetrahydrofuran, or toluene. Suitable bases may be organic (such as pyridine, triethylamine, or piperidine), inorganic (such as sodium hydroxide, potassium carbonate, sodium hydride) or organometallic (such as potassium t-butoxide, sodium methoxide, lithium diisopropylamide), with organic or organometallic bases being preferred.

The compound of formula (III) above is generally present in a molar excess. Preferably from about 1 to about 2 moles of the compound of formula (III) are present, more preferably from about 1.05 to about 1.1 moles.

Compounds of formula (III) in which Ar, R_3, R_4 and R_5 are as defined above, provided that when R_3 and R_5 are both cyano R_4 is not -C(O)OR_8, are novel and thus constitute a feature of the present invention.

Compounds of formula (II) may be prepared by the reaction of a compound of

formula (V):

$$R_3—CH_2R_4$$
$$(V)$$

wherein R_3 and R_4 are as defined above with a compound of the formula R_5CH_2L wherein R_5 is as defined above and L is a leaving group, in the presence of a base. Examples of suitable leaving groups include halogen and tosylate (preferably halogen). The base is generally a strong base (*e.g.* sodium hydride or n-butyl lithium) and the reaction is generally performed in an aprotic solvent (*e.g.* tetrahydrofuran) at a temperature from about -78°C to about 0°C. Compounds of formula (II), in which R_5 is cyano and R_3 and R_4 are as defined above, provided that when R_3 is -CN then R_4 is not -C(O)OR_8, are also novel and thus constitute a further feature of the present invention.

The following non-limiting examples illustrate the invention.

Example 1

Preparation of 3-(4-chlorophenylsulfonyl)-4-cyanobutan-2-one

To a 300 mL reaction flask was added 2.4 g (59.3 mmole) sodium hydride (60% dispersion in oil) and 10 mL hexanes. The hexanes were removed by pipette and replaced by 60 mL dry tetrahydrofuran (THF). The suspension was cooled to -15°C and a solution of 12.0 g (51.6 mmole) 4-chlorophenylsulfonyl acetone in 50 mL THF was added via addition funnel over 20 minutes maintaining the reaction temperature below -12°C. The resulting yellow solution was removed from the cold bath and stirred at room temperature for 30 min. The solution was recooled to -5°C and 3.8 mL (54.1 mmole) bromoacetonitrile was added dropwise via addition funnel. After 5 min, the reaction mixture was removed from the cold bath and stirred at room temperature overnight. The reaction was quenched with 1 mL of saturated ammonium chloride and transferred with 100 mL of dichloromethane to a separatory funnel containing 100 mL brine. The organic layer was separated and the aqueous layer was back extracted once with 50 mL more dichloromethane. The combined organics were then dried with sodium sulfate, filtered, concentrated, and chromatographed through a bed of silica gel using 1:1 hexane: dichloromethane. Isolation gave 8.2 g (59% yield) of 3-(4-chlorophenylsulfonyl)-4-cyanobutan-2-one, a yellow oil that was 90% pure by HPLC. ^1H NMR ($CDCl_3$) indicated desired product as the major component: d 7.6 (m, 4H), 4.42 (dd, 1H), 2.78 (m, 2H), 2.48 (s, 3H).

Example 2

Preparation of 3-(4-chlorophenylsulfonyl)-3-[(2,6-dichloro-4-trifluoromethylphenyl)azo]-4-cyanobutan-2-one

To a 250 mL reaction flask was added 2.0 g (35.7 mmole) potassium hydroxide pellets followed by 30 mL water and 30 mL methanol. To this solution was added 6.9 g (25.5 mmole) of compound 3-(4-chlorophenylsulfonyl)-4-cyanobutan-2-one. Once homogeneous, 23.2 mmole of the hydrogensulfate diazonium salt of 2,6-dichloro-4-trifluoromethylaniline was added in one portion to the reaction medium. After stirring for 45 minutes at room temperature the reaction mixture was worked-up by adding water and dichloromethane. The layers were separated and the organic layer back extracted once with dichloromethane (50 mL). The combined organics were dried (Na_2SO_4), filtered, concentrated and chromatographed through silica gel using hexane:ethyl acetate mixture. Isolation gave 5.1 g (43%) the title compound as a glassy semi-solid which HPLC indicated was 98% pure and ^{1}HNMR indicated as desired product: d 7.6 (m, 4H), 7.65 (s, 2H), 3.3 (dd, 2H), 2.42 (s, 3H).

Example 3

Preparation of 3-acetyl-5-amino-4-(4-chlorophenyl)sulfonyl-1-(2,6-dichloro-4-trifluoromethylphenyl)pyrazole

Two drops of triethylamine were added to 0.51 g (1.0 mmole) 3-(4-chlorophenylsulfonyl)-3-(2,6-dichloro-4-trifluoromethylphenylazo)-4-cyanobutan-2-one dissolved in 10 mL dichloromethane. After stirring overnight at room temperature, the reaction was worked-up by adding additional dichloromethane and washing with water. The organic layer was separated, dried (Na_2SO_4), filtered and concentrated to give 0.55 g of the title compound that was 94% pure by HPLC, m.p. 158°C.

Example 4

Preparation of 2-(4-chlorophenylsulfonyl)succinonitrile

To a 500 mL reaction flask was added 2.0 g (51.0 mmole) sodium hydride (60% dispersion in oil) and 20 mL hexanes. The hexanes were removed by pipette and replaced by 90 mL dry tetrahydrofuran (THF). The suspension was cooled to 0°C and a solution of 10.0 g (46.4 mmole) 4-chlorophenylsulfonyl acetonitrile in 90 mL THF was added via addition funnel over 10 minutes maintaining the reaction temperature below 12°C. The resulting solution was removed from the cold bath and stirred at room temperature for 40 min. The solution was recooled to 0°C and 3.4 mL (48.7 mmole) bromoacetonitrile in 5 mL THF was added dropwise via addition

funnel. After 5 minutes, the reaction was removed from the cold bath and stirred at room temperature for two hours. The reaction was quenched with 1 mL of saturated ammonium chloride and concentrated to an oil which was transferred with 150 mL of dichloromethane to a separatory funnel containing 120 mL water. The organic layer was separated and washed once more with 120 mL water and once with 120 mL brine. The organic layer was then dried (Na_2SO_4), filtered, concentrated, and chromatographed through a bed of silica gel using 85:15 hexane:ethyl acetate. Isolation gave 1.4 g (12% yield) of the title compound as a yellow powder that was 96% pure by HPLC, m.p. 130-137°C.

Example 5

Preparation of 2-(4-chlorophenylsulfonyl)-
2-(2,6-dichloro-4-trifluoromethyl)phenylazo succinonitrile

To a 50 mL reaction flask was added 0.45 g (1.77 mmole) of 2-(4-chlorophenylsulfonyl)succinonitrile in 15 mL methanol. Once homogeneous, 1.61 mmole of the hydrogensulfate diazonium salt of 2,6-dichloro-4-trifluoromethylaniline was added in one portion to the reaction medium. After stirring 45 min at room temperature the reaction mixture was worked-up by adding brine and dichloromethane. The layers were separated and the organic layer was dried (Na_2SO_4), filtered, concentrated and chromatographed through silica gel using 90:10 hexane:ethyl acetate. Isolation gave 0.33 g (42%) of the title compound, a red crystalline solid which ^{19}F NMR indicated was over 95% pure, m.p. 45-50°C.

Example 6

Preparation of 5-amino-3-cyano-4-(4-chlorophenylsulfonyl)-
1-(2,6-dichloro-4-trifluoromethylphenyl)pyrazole

Three drops of triethylamine were added to 0.3 g (0.61 mmole) of 2-(4-chlorophenylsulfonyl)-2-(2,6-dichloro-4-trifluoromethyl)phenylazo succinonitrile in 20 mL dichloromethane. After stirring two hours at room temperature the reaction was worked-up by diluting with dichloromethane and partitioning from water. The layers were separated and the aqueous layer was back-extracted once with dichloromethane. The combined organics were dried (Na_2SO_4) filtered, concentrated and chromatographed through silica gel eluting with 90:10 hexane:ethyl acetate. Isolation gave 0.14 g (47% yield) of the title compound, 100% pure by HPLC as an orange foam, m.p. 90-95°C.

Example 7

Preparation of ethyl 2,3-dicyano-2-(2,6-dichloro-4-trifluoromethyl)phenylazo propionate

22.1 Mmole of ethyl dicyanopropionate in 20 mL absolute ethanol was cooled to 0°C, and 20.9 mmole of the hydrogensulfate diazonium salt of 2,6-dichloro-4-trifluoromethylaniline was added via addition funnel over 15 minutes. The reaction was warmed to room temperature and stirred overnight. The reaction was worked-up by adding water and dichloromethane. The layers were separated and the aqueous layer was back extracted once with dichloromethane. The combined organics were washed once with brine and the organic layer was dried (Na_2SO_4), filtered, concentrated and chromatographed through silica gel using 90:10 hexane:ethyl acetate. Isolation gave 2.7 g (33%) of the title compound as a red viscous oil which contained 82% desired azo product and 13% of the corresponding hydrazone. ^1H NMR ($CDCl_3$) indicated desired product as the major component: d 7.70 (s, 2H), 4.44 (m, 2H), 3.58 (q, 2H), 1.39 (t, 3H).

Example 8

Preparation of 5-amino-3-cyano-1-(2,6-dichloro-4-trifluoromethylphenyl)-4-carboethoxypyrazole

To a 100 mL reaction flask was added 0.51 g (1.30 mmole) ethyl 2,3-dicyano-2-(2,6-dichloro-4-trifluoromethyl)phenylazo propionate in 20 mL tetrahydrofuran. The reaction was cooled to -78°C and 0.52 g (1.30 mmole) sodium hydride (60% dispersion in oil) was added in one portion. The reaction mixture warmed to room temperature overnight. Two grams of silica gel and 40 mL ethyl acetate were added to the reaction mixture and the slurry was concentrated and chromatographed through silica gel eluting with 90:10 hexane:ethyl acetate (1 L) and 80:20 (2 L). Isolation gave 0.16 g (38% yield based on 82% pure starting material), a solid that was 99% pure by HPLC, m.p. 201.5-202.5°C.

Example 9

Preparation of hydrogensulfate diazonium salt of 2,6-dichloro-4-trifluoromethylaniline

To a 100 mL reaction flask was added 5.3 g (23.2 mmole) 2,6-dichloro-4-trifluoromethylaniline dissolved in 45 mL glacial acetic acid. The solution was cooled in an ice water bath and 3.8 g (30.1 mmole) nitrosylsulfuric acid was added in one portion. The reaction was removed from the ice bath and stirred at room temperature

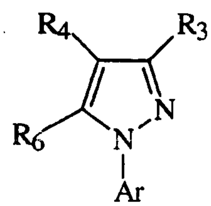
for two hours. The resulting diazonium salt was used without purification.

The compounds of formula (IV) prepared by the process of the present invention are useful as pesticides.

While the invention has been described in terms of various preferred embodiments, the skilled artisan will appreciate that various modifications, substitutions, omissions and changes may be made without departing from the spirit thereof. Accordingly, it is intended that the scope of the present invention be limited solely by the scope of the following claims, including equivalents thereof.

WHAT IS CLAIMED IS:

1. A process for preparing a compound having the formula:



(IV)

wherein:

Ar is optionally substituted phenyl or optionally substituted pyridyl;

R_3 is $-C(O)R_8$, -CN, $-CO_2H$, $-C(O)NHR_8$, -CHO, $-C(O)CO_2R_8$, $-S(O)_mR_8$, $-C(O)CH_2Het$, Het, $-C(O)CH_2R_9$, -C(O)(C_1-C_6 alkyl), -C(O)(C_1-C_6 haloalkyl), -C(O)styryl, halogen, $-C(O)OR_8$, $-P(O)(OR_8)_2$, $-P(S)(OR_8)_2$, $-NO_2$, R_9 or $-S(O)_m$styryl;

R_4 is as defined for R_3 excluding -CN and halogen;

m is 0, 1 or 2;

R_6 is $-NH_2$, -OH or $-CH_3$;

R_8 is C_1-C_6 alkyl, C_1-C_6 haloalkyl, R_9 or Het;

Het is a 5- or 6-membered heterocyclic ring, said ring having from one to three ring heteroatoms which are the same or different selected from the group consisting of nitrogen, sulfur and oxygen, each carbon atom of said ring being unsubstituted or being substituted by halogen, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, cyano, nitro, amino, N-(C_1-C_6 alkyl)amino, N,N-di(C_1-C_6 alkyl)amino, OH, $-S(O)_m$(C_1-C_6 alkyl) or $-S(O)_m$(C_1-C_6 haloalkyl); and

R_9 is phenyl optionally substituted by one or more members selected from the group consisting of halogen, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, cyano, nitro, amino, N-(C_1-C_6 alkyl)amino, N,N-di(C_1-C_6 alkyl)amino, -OH, $-S(O)_m$(C_1-C_6 alkyl) and $-S(O)_m$(C_1-C_6 haloalkyl);

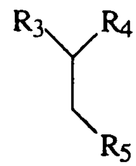
said process comprising:

(a) reacting a compound having the formula:

$$Ar{-}N{\equiv}N^{+}X^{-}$$

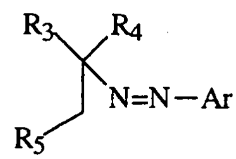
(I)

wherein Ar is as defined above and X is a compatible anion, with a compound having the formula:



(II)

wherein R_3 and R_4 are as defined above and R_5 is -CN, -C(O)OR$_8$ or -C(O)(C$_1$-C$_6$ alkyl), to afford the corresponding compound having the formula:



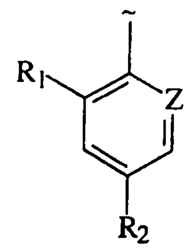
(III)

wherein R_3, R_4, R_5 and Ar are as defined above; and

(b) subjecting the compound of formula (III) thus obtained to rearrangement to afford the corresponding compound of formula (IV).

2. The process according to Claim 1, wherein Ar is phenyl having from 0 to 5 substituents or pyridyl having from 0 or 4 substituents, each substituent when present being selected from the group consisting of halogen, CN, NO_2, C_1-C_6 haloalkyl, C_1-C_6 haloalkoxy, $S(O)_mCF_3$, SF_5 and R_{10}; and R_{10} is phenyl optionally having from one to five substituents selected from the group consisting of halogen, C_1-C_6 alkyl, C_1-C_6 haloalkyl, cyano(C_1-C_6 alkyl), cyano, nitro, amino, hydrazino, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, (C_1-C_6 haloalkyl)carbonyl, formyl, (C_1-C_6 alkyl)carbonyl, thiocarbamoyl, carbamoyl, (C_1-C_6 alkoxy)carbonyl, SF_5 and $R_8S(O)_m$, two adjacent phenyl substituents being optionally joined together to form a 1,3-butadienylene, methylenedioxy or halomethylenedioxy group.

3. The process according to Claim 1 or Claim 2 wherein Ar has the formula:



wherein:

Z is a trivalent nitrogen atom or a C-R_7 radical, the other three valences of the carbon atom forming part of the aromatic ring;

R_1 and R_7 are, independently of each other, hydrogen, halogen, CN or NO_2; and

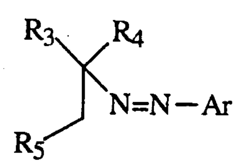
R_2 is halogen, C_1-C_6 haloalkyl, C_1-C_6 haloalkoxy, $S(O)_mCF_3$, SF_5 or R_{10}.

4. The process according to any one of the foregoing claims wherein R_3 is -CN or -C(O)R_8.

5. The process according to any one of the foregoing claims wherein R_4 is $S(O)_mR_8$ wherein R_8 is C_1-C_6 alkyl, C_1-C_6 haloalkyl or R_9.

6. A process according to any one of the foregoing claims wherein the molar ratio of (I):(II) is from about 1:1 to about 1:2.

7. A process for preparing a compound having the formula:



(III)

wherein:

Ar is optionally substituted phenyl or optionally substituted pyridyl;

R_3 is -C(O)R_8, -CN, -CO_2H, -C(O)NHR_8, -CHO, -C(O)CO_2R_8, -$S(O)_mR_8$, -C(O)CH_2Het, Het, -C(O)CH_2R_9, -C(O)(C_1-C_6 alkyl), -C(O)(C_1-C_6 haloalkyl), -C(O)styryl, halogen, -C(O)OR_8, -P(O)(OR_8)$_2$, -P(S)(OR_8)$_2$, -NO_2, R_9 or -$S(O)_m$styryl;

R_4 is as defined for R_3 excluding -CN and halogen;

m is 0, 1 or 2;

R_5 is -CN, -C(O)OR$_8$ or -C(O)(C_1-C_6 alkyl);

R_8 is C_1-C_6 alkyl, C_1-C_6 haloalkyl, R_9 or Het;

Het is a 5- or 6-membered heterocyclic ring, said ring having from one to three ring hetereoatoms which are the same or different selected from the group consisting of nitrogen, sulfur and oxygen, each carbon atom of said ring being unsubstituted or being substituted by halogen, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, cyano, nitro, amino, N-(C_1-C_6 alkyl)amino, N,N-di(C_1-C_6 alkyl)amino, OH, -S(O)$_m$(C_1-C_6 alkyl) or -S(O)$_m$(C_1-C_6 haloalkyl); and

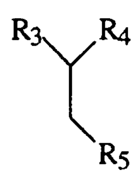
R_9 is phenyl optionally substituted by one or more members selected from the group consisting of halogen, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, cyano, nitro, amino, N-(C_1-C_6 alkyl)amino, N,N-di(C_1-C_6 alkyl)amino, -OH, -S(O)$_m$(C_1-C_6 alkyl) and -S(O)$_m$(C_1-C_6 haloalkyl);

said process comprising reacting a compound having the formula:

$$Ar{-}N{\equiv}N^{+}X^{-}$$

(I)

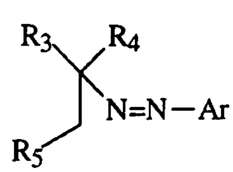
wherein Ar is as defined above and X is a compatible anion, with a compound having the formula:



(II)

wherein R_3, R_4 and R_5 are as defined above.

8. A compound having the formula:



(III)

wherein:

Ar is optionally substituted phenyl or optionally substituted pyridyl;

R_3 is -C(O)R_8, -CN, -CO_2H, -C(O)NHR_8, -CHO, -C(O)CO_2R_8, -$S(O)_mR_8$, -C(O)CH_2Het, Het, -C(O)CH_2R_9, -C(O)(C_1-C_6 alkyl), -C(O)(C_1-C_6 haloalkyl), -C(O)styryl, halogen, -C(O)OR_8, -P(O)(OR_8)$_2$, -P(S)(OR_8)$_2$, -NO_2, R_9 or -$S(O)_m$styryl;

R_4 is as defined for R_3 excluding -CN and halogen;

m is 0, 1 or 2;

R_5 is -CN, -C(O)OR_8 or -C(O)(C_1-C_6 alkyl);

R_8 is C_1-C_6 alkyl, C_1-C_6 haloalkyl, R_9 or Het;

Het is a 5- or 6-membered heterocyclic ring, said ring having from one to three ring hetereoatoms which are the same or different selected from the group consisting of nitrogen, sulfur and oxygen, each carbon atom of said ring being unsubstituted or being substituted by halogen, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, cyano, nitro, amino, N-(C_1-C_6 alkyl)amino, N,N-di(C_1-C_6 alkyl)amino, OH, -$S(O)_m$(C_1-C_6 alkyl) or -$S(O)_m$(C_1-C_6 haloalkyl); and

R_9 is phenyl optionally substituted by one or more members selected from the group consisting of halogen, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, cyano, nitro, amino, N-(C_1-C_6 alkyl)amino, N,N-di(C_1-C_6 alkyl)amino, -OH, -$S(O)_m$(C_1-C_6 alkyl) and -$S(O)_m$(C_1-C_6 haloalkyl);

with the proviso that when R_3 is -CN and R_5 is -CN, then R_4 cannot be -C(O)OR_8.

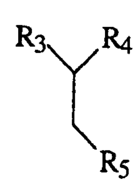
9. The compound according to Claim 8, which is:

3-(4-chlorophenylsulfonyl)-3-(2,6-dichloro-4-trifluoromethylphenylazo)-4-cyanobutan-2-one;

2-(4-chlorophenylsulfonyl)-2-(2,6-dichloro-4-trifluoromethyl)phenylazo succinonitrile; or

ethyl 2,3-dicyano-2-(2,6-dichloro-4-trifluoromethyl)phenylazo propionate.

10. A compound having the formula:



(II)

wherein:

R_3 is -C(O)R_8, -CN, -CO_2H, -C(O)NHR_8, -CHO, -C(O)CO_2R_8, -$S(O)_mR_8$, -C(O)CH_2Het, Het, -C(O)CH_2R_9, -C(O)(C_1-C_6 alkyl), -C(O)(C_1-C_6 haloalkyl), -C(O)styryl, halogen, -C(O)OR_8, -P(O)$(OR_8)_2$, -P(S)$(OR_8)_2$, -NO_2, R_9 or -$S(O)_m$styryl;

R_4 is as defined for R_3 excluding -CN and halogen;

m is 0, 1 or 2;

R_5 is -CN;

R_8 is C_1-C_6 alkyl, C_1-C_6 haloalkyl, R_9 or Het;

Het is a 5- or 6-membered heterocyclic ring, said ring having from one to three ring hetereoatoms which are the same or different selected from the group consisting of nitrogen, sulfur and oxygen, each carbon atom of said ring being unsubstituted or being substituted by halogen, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, cyano, nitro, amino, N-(C_1-C_6 alkyl)amino, N,N-di(C_1-C_6 alkyl)amino, OH, -$S(O)_m$(C_1-C_6 alkyl) or -$S(O)_m$(C_1-C_6 haloalkyl); and

R_9 is phenyl optionally substituted by one or more members selected from the group consisting of halogen, C_1-C_6 alkyl, C_1-C_6 haloalkyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy, cyano, nitro, amino, N-(C_1-C_6 alkyl)amino, N,N-di(C_1-C_6 alkyl)amino, -OH, -$S(O)_m$(C_1-C_6 alkyl) and -$S(O)_m$(C_1-C_6 haloalkyl);

with the proviso that when R_3 is -CN, then R_4 cannot be -C(O)OR_8.

11. The compound according to Claim 10, which is:
3-(4-chlorophenylsulfonyl)-4-cyanobutan-2-one; or
2-(4-chlorophenylsulfonyl)succinonitrile.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 98/01226

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C07D231/10 C07D231/44 C07D231/38 C07C317/48 C07C317/44 C07C255/65

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C07D C07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EASTMAN R H ET AL.: "The reaction of 2,5-dimethylfuran with p-nitrobenzenediazonium chloride" JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, vol. 70, no. 3, 3 April 1948, pages 962-4, XP002073061 Washington DC, US see the whole document ---	1-11
X	DE 29 28 136 A (BAYER AG) 29 January 1981 see the whole document, particularly pages 13, 14, bridging paragraph ---	1-11

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 July 1998	12/08/1998
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Allard, M

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	PHILLIPS R R : "The Japp-Klingemann reaction" ORGANIC REACTIONS, vol. 10, 1959, pages 143-78, XP002073062 John Wiley & Sons, New York, US cited in the application see the whole document, particularly page 154	1-11
A	US 5 232 940 A (HATTON L R ET AL.) 3 August 1993 cited in the application see the whole document	1-11
X	HECKENDORN R: "Novel heterocycles by the malonic ester variation of the Japp-Klingemann reaction" BULLETIN DES SOCIÉTÉS CHIMIQUES BELGES, vol. 95, no. 11, November 1986, pages 921-43, XP002073063 Brussels, BE see the whole document, particularly page 929, compound 38, page 930, scheme 12, and page 931, compounds 41 and 47	1-11
X	WO 93 06089 A (IMPERIAL CHEMICAL INDUSTRIES PLC) 1 April 1993 cited in the application see the whole document, particularly example 1, stage 3	1-11
X	DE 36 02 524 A (BAYER AG) 30 July 1987 see the whole document, particularly example 4, second part	7,8
X	US 3 140 226 A (STEPHENS J A ET AL) 7 July 1964 see the whole document	10
X	US 2 978 480 A (LUCKENBAUGH R W ET AL.) 4 April 1961 see the whole document	10
X	REDMAN R P ET AL.: "Elimination and addition reactions. Part 35. Substituent effects on alkene-forming eliminations from carbanions " JOURNAL OF THE CHEMICAL SOCIETY, PERKIN TRANSACTIONS II, 1978, pages 1135-44, XP002073064 London, GB see tables 3 and 6, substrates 21 and 22	10

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP 98/01226

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: -
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Concerning claim 10, the search revealed such a large number of particularly relevant documents, in particular with regard to novelty, that the drafting of a comprehensive Search Report is not feasible. The cited documents are considered as to form a representative sample of the revealed documents, duly taking into account their relevance with respect to the subject-matter as illustrated by the examples.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte ional Application No
PCT/EP 98/01226

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 98/01226

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		US 3238094 A	01-03-1966
US 2978480 A	04-04-1961	NONE	

Form PCT/ISA/210 (patent family annex) (July 1992)